

## New LCA Theses

### Information Model for the Integration of Ecological Assessments into Virtual Product Development

Dr.-Ing. Thesis of Sebastian Leibrecht<sup>1,2</sup>

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Products are – directly and indirectly – major sources for ecological impact. The true ecological performance of products can only be determined by the consideration of impacts arising from their entire lifecycle, and by including all known damage categories into the assessment. Such a methodology is outlined in ISO 14040: the Life Cycle Assessment.

Powerful tools and methods are necessary to integrate the continuous consideration of ecological aspects into mainstream product development. Efficient reuse of existing virtual product data, an intelligent and automatic prediction of potential processes of a product's life, and a user interface that enables fast and easy back tracking of ecological weak points are major requirements. Since products are most often designed using Computer Aided Design (CAD) systems, the interoperability between LCA and CAD are vital for reaching such a goal. Today's LCA tools' information management differs substantially from paradigms of the CAD technology, thus, their effective use within modern product development is quite restricted. The understanding for the product developer is complicated and manual remodelling of product data is required.

This thesis develops tools and methods for ecological assessments, based on a virtual, three-dimensional digital product representation. The outcome of this thesis is especially applicable to complex technical products, from household appliances to vehicles. It focuses from the beginning on the compatibility to today's CAD systems, and considers the product's assemblies, parts, and manufacturing features. Each of these components can have an individual lifecycle, consisting of various processes through which a component might go.

The foundation of this research is the development of an information model that manages product information and ecological information, and serves as a core system for ecological assessments. It is based on a CAD product structure, which represents the structure, geometry, and materials of prod-

ucts. It adds entities and parameters for the definition of lifecycles to the products' components. The connection to an ecological databases and the integration of the proper functionality enables the undertaking of ecological assessments, based on a purely digital product description. The main innovation is the enforcement of compatibility to CAD product models from the first items in the new model on. The entire model is object-oriented and has been created and documented in the Unified Modelling Language (UML). It consists of static class-models and dynamic object-models.

The research outcome has been implemented to a modular software system, which includes the core model, a graphical user interface, a tool for synchronisation with CAD data (using the CAD system Pro/Engineer as an example), an open programmable interface (API) for further extensions, and an extendable ecological database containing single scores, equivalents, and inventories. It enables the reuse of existing CAD data or the modelling of new product structures. Subsequently, individual lifecycles can be designed for each of the product's components. During an assessment, suitable ecological indicators for the lifecycle processes are automatically derived and adapted to the actual scenario, and results are automatically normalised to a functional unit, using the components' lifetimes. The outcome of an analysis can be displayed and exported as tables or charts, arranged by a product's structure, by its lifecycle stages, or by the available types of ecological indicators. The model can automatically keep the consistency of the components' mass properties.

Next to the actual research, the thesis gives a comprehensive introduction to ecological issues related to product-development and further economic and social issues, and examines existing methodologies and technologies.

More information and a download of the software can be found at [www.ecologicad.com](http://www.ecologicad.com).

<sup>1</sup> This thesis is the Dr.-Ing. thesis of Sebastian Leibrecht (University of Technology in Darmstadt, Germany). The research has been undertaken at the Collaborative Research Centre 392 in Darmstadt, Germany ([www.sfb392.tu-darmstadt.de](http://www.sfb392.tu-darmstadt.de)) and at the Centre for Design at RMIT University, Melbourne, Australia ([www.cfd.rmit.edu.au](http://www.cfd.rmit.edu.au)). The complete thesis is published at Shaker Publishing ([www.shaker.de](http://www.shaker.de)) under ISBN 3-8322-3964-2. This research's internet site can be found at [www.ecologicad.com](http://www.ecologicad.com).

<sup>2</sup> Leibrecht S (2005): Fundamental Principles for CAD-based Ecological Assessments. Int J LCA 10 (6) 436–444

## Book Reviews

### The Hitch Hiker's Guide to LCA

An orientation in LCA methodology and application

**Authors:** Baumann, Henrikke, Tillman, Anne-Marie

**Publisher:** Studentlitteratur, Lund 2004. ISBN 91-44-02364-2

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Having been a hitch hiker myself as a student, I wondered what this way of travelling might have to do with Life Cycle Assessment? The explanation is given at pp. 7 and 8 of this hilarious book: the title is a reference to a book by Douglas Adams<sup>1</sup> and more specifically to the frustrating answer given by a supercomputer called 'Deep Thought'<sup>2</sup> to a question relating to the last secret of the universe: '42'. This meanwhile became popular as '42 method'. The book tries the contrary: to give a down-to-earth textbook of LCA as it is – or at least should be – used by most practitioners. Modern theory and latest developments of LCA are not ignored, but the bulk of the book presents LCA in a form that can be used by well-trained students, researchers and practitioners in industry and consultancy.

In some way it is astonishing that, 15 years after the birth of modern LCA, such a book (in English) has not been written before. There are several excellent monographs on the market, but no genuine textbook. This new textbook fills the gap. It has 13 chapters (organized in three parts: Introduction to LCA, 50 pp.; LCA methodology, 160 pp; LCA

applications, 110 pp.) and additionally exercises (110 pp.), appendices (general inventory data, characterisation indicators and weighting indices), Glossary, Index (a total of 543 pp.).

Since I assume (and strongly suggest) that most readers not yet owing this book will order and read it, I am not going to describe it in detail. Such a description could not reproduce the spirit of the book which I described above as 'hilarious'. It is the style, the lucid analysis of the method, the focus on feasible and actually used methods and the didactic skill of the exercises, which make this book unique.

As one who witnessed the early time of 'proto-LCAs' [1], I am especially pleased that this phase is correctly described, including the scientific portrait of the Swedish pioneer Gustav Sundström.

Since my main professional occupation is now the critical review of LCAs and related studies, I read chapter 7 ('Critical review of LCA') especially carefully. It provides the essence of this work, refers to the origin and the necessity, the basis in ISO 14040, and gives guidance how to perform a critical review.

Chapters 9 to 13 are devoted to LCA applications. I only cite the titles of these chapters to show the broad scope of this part 3: LCA and product development (9); Green marketing and LCA (10); LCA for production processes (11); LCA and waste management (12) and Organising LCA activities in a company (13).

[1] Klöpffer W (2006): The Role of SETAC in the Development of LCA. Int J LCA 11 (3), May edition

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<sup>1</sup> Douglas Adams: The Hitch Hiker's Guide to the Galaxy.

<sup>2</sup> Honny soit qui mal y pense